Short-term debt and financial crises: What we can learn from U.S. Treasury supply

Arvind Krishnamurthy
Northwestern-Kellogg and NBER

Annette Vissing-Jorgensen
Berkeley-Haas, NBER and CEPR

1. Motivation

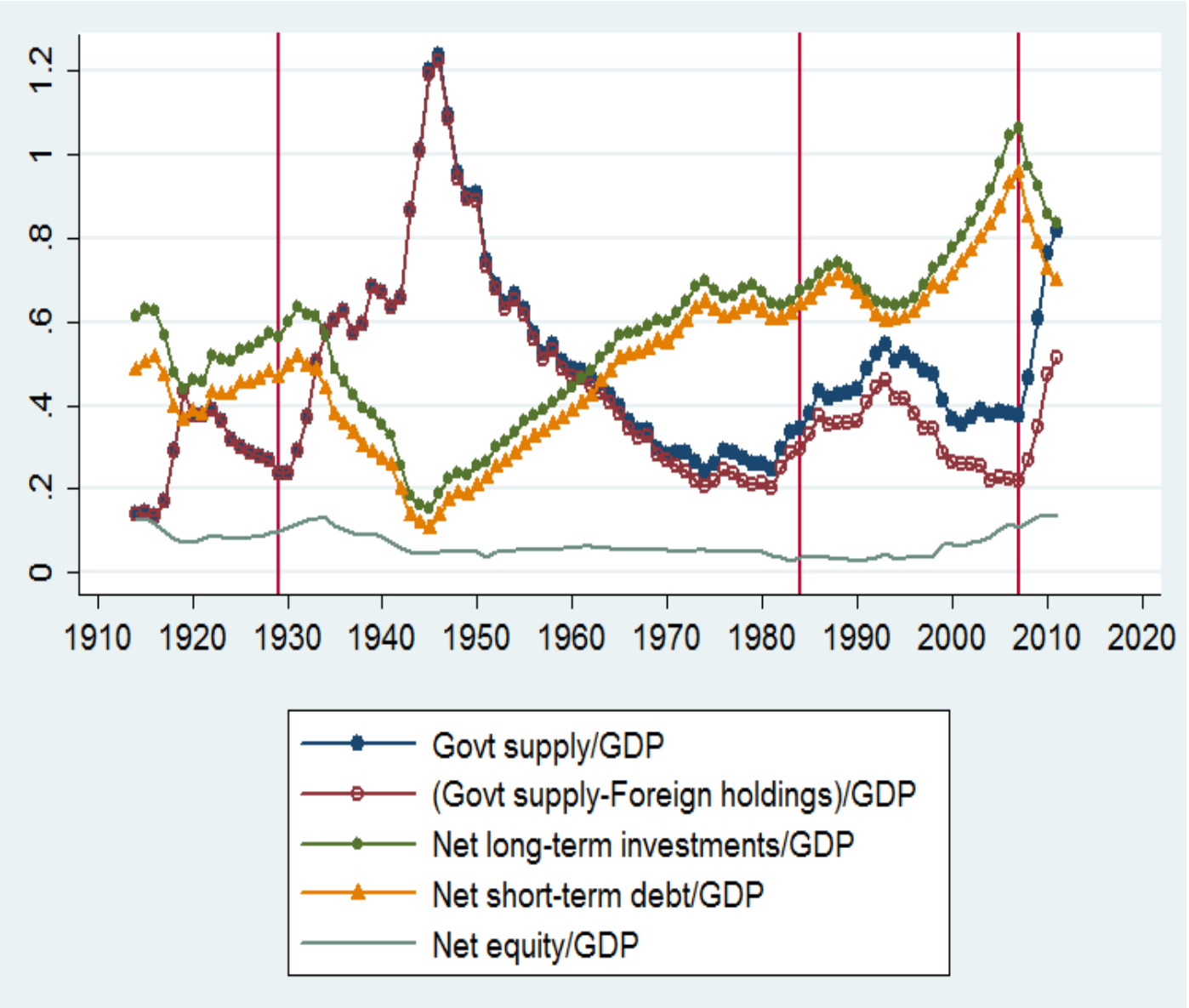
- Why so much short-term financing of the financial sector?
  1) Demand from some agents for safe, liquid assets (properties disproportionately possessed by short-term bank debt)

  Diamond and Dybvig (1983), Gorton and Pennacchi (1990), Dang, Gorton and Holmstrom (2010)

  2) Govt. deposit insurance/central bank lender of last resort
  3) Tax advantages to debt
  4) Agency theory (Calomiris and Kahn, 1990, Diamond and Rajan 1998).

  We provide a new test of 1) based on variation in the supply of government securities (mainly Treasuries).

Figure 2. Impact of government supply on financial sector balance sheet, 1914-2011
Panel A. Impact on short, long, and equity net categories



- Krishnamurthy and Vissing-Jorgensen (JPE, 2012): Treasuries are valued for their liquidity and safety.

- If financial sector short-term debt is due to 1) (demand), Treasury supply should therefore *crowd out* the private sector's production of safe, liquid assets via effects on the equilibrium prices of safety and liquidity.

- We construct an overall balance sheet for the entire U.S. financial sector (both traditional banks and all the other parts) back to 1914 and show that changes in Treasury supply has very large effects on this balance sheet.

Of course, you may be worried about endogeneity/reverse causality:

- US Treasury supply/GDP increases are driven mainly by war spending and recessions following financial crisis, with decreases during recoveries.

- Could these factors be driving net short-term debt and net LT investments in opposite direction so our relation is not causal?

- Possibly, but the advantage of our story is that it is a standard banking model with bank quantities responding to documented price incentives driven by Treasuries.

We take four approaches to address potential endogeneity/reverse causality:

(1) Test additional predictions of the model.
    (1) Prices move in the right direction
(2) Include business cycle controls. Drop most problematic years.
(3) Exploit a demand shock for safe/liquid assets.
(4) Explore the impact of government supply on the composition of consumption expenditures (``Rajan-Zingales identification").

2. Background: Treasuries are valued for their extreme liquidity, extreme safety

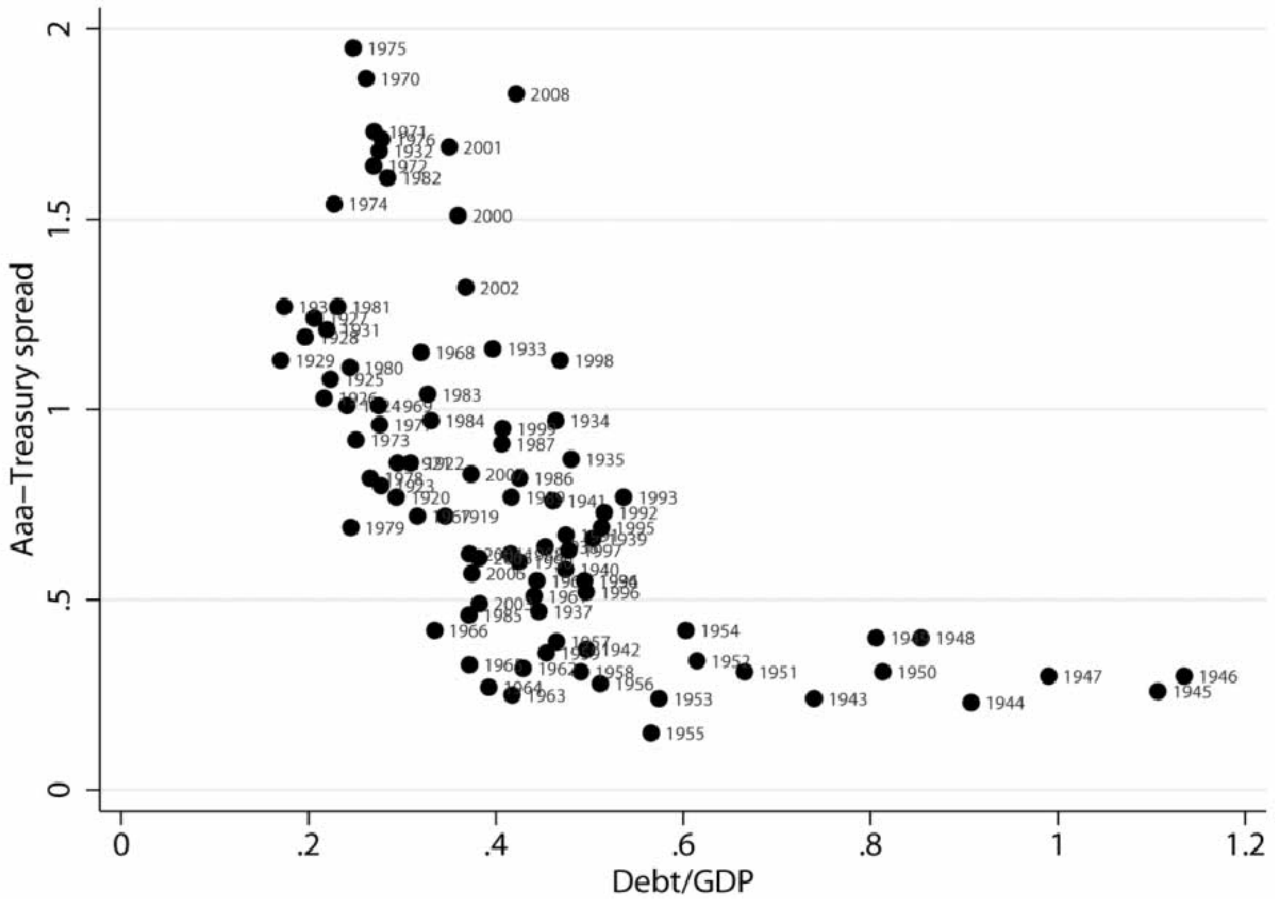


FIG. 1.—Corporate bond spread and government debt. The figure plots the Aaa-Treasury corporate bond spread (*y* axis) against the debt-to-GDP ratio (*x* axis) on the basis of annual observations from 1919 to 2008. The corporate bond spread is the difference between the percentage yield on Moody's Aaa long-maturity bond index and the percentage yield on long-maturity Treasury bonds.

Debt/GDP down 1 std. dev. → Aaa-Treas up 44 bps, Baa-Treas up 77 bps.

Using kink-specification, Baa-Treasury: Average Treasury convenience yield 1926-2008 is 73 bps

- Relation is largely unaffected by controlling for the default risk in corporate bonds
- It's present for both long and short spreads so both long and short Treasuries are special

Some private debt is also special

- Our earlier work also showed that high grade corporate bonds and commercial paper have yields that are also reduced by safety/liquidity effects suggests that some private assets are also special.

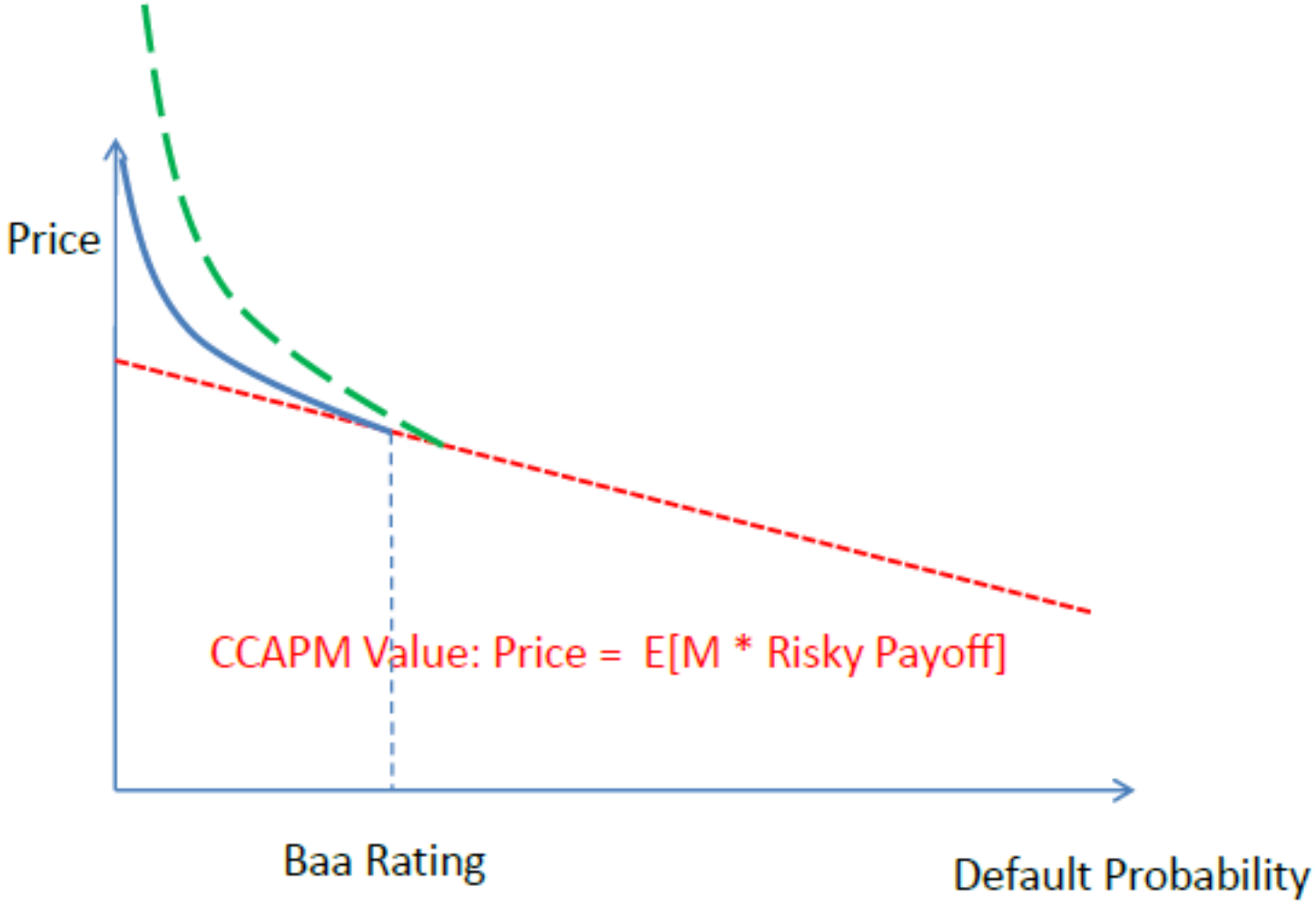
- Our earlier work didn't show that financial sector short-term debt is special in terms of yield, but it is:
  - Checking deposits pay very low yields so must be special (that's the whole point of the money literature on transactions services)
  - Average rates of time and savings accounts (from the FDIC, 1934-2008 for now) do suggest such accounts have low yields due to safety/liquidity effects, relative to low-grade corporate bonds.

	Baa-(Time&Savings)	CPP2-(Time&Savings)
ln(Debt/GDP)	-1.41	-2.63
	(-2.32)	(-3.11)
EDF	0.93	-0.88
	(1.38)	(-0.96)
Slope of yield curve		
(10-year minus 3-month)	0.64	-0.77
	(5.03)	(-4.67)
Constant	1.02	0.69
	(1.66)	(0.75)
R2	0.524	0.532
N	74	35
Time period	1935-2008	1974-2008

Note: t-statistics in parenthesis. OLS estimations with standard error calculated assuming AR(1) error terms. For EDF, we use fitted values from a regression of EDF on stock market volatility prior to 1963, based on a regression run using data from 1963-2008.

	A. Price of Safety				B. Price of Liquidity	
	$S^{\text{Baa-Aaa}}$		$S^{\text{P2-P1}}$		$S^{\text{FDIC-insured CDs–Bills}}$	$S^{\text{Time/Savings Accounts–Bills}}$
	1926–2008 (1)	1926–2008 (2)	1974–2007 (3)	1974–2007 (4)	1984–2008 (5)	1935–65 (6)
Log(debt/GDP)	−.510		−.888		−1.884	−.690
	[−3.45]		[−4.34]		[−1.71]	[−2.57]
Log(debt > 10-year maturity/GDP)*		−.304				
		[−2.44]				
Log(debt ≤ 1-year maturity/GDP)*				−1.462		
				[−2.84]		
Volatility	5.031	6.232				
	[6.47]	[6.65]				
EDF			.074	.019		
			[.35]	[.07]		
Slope	.232	.211	.014	.055	.101	1.181
	[4.20]	[3.29]	[.42]	[1.13]	[.88]	[10.04]
Constant	.660	.264	−.508	−2.679	−1.486	−.170
	[4.54]	[.74]	[−2.39]	[−2.47]	[−1.52]	[−.95]
Observations	83	83	34	34	25	31
R^2	.600		.497		.233	.898
Estimation method	OLS	IV	OLS	IV	OLS	OLS
Error term	AR(1)	AR(1)	AR(1)	AR(1)	AR(1)	AR(1)

What is "safety"? Not C-CAPM



3. A simple model

- Two dates, 0 and 1.
- Type N agents (measure 1) have a demand for short-term debt. Are unsophisticated and do not hold bank equity
- Type F agents (measure 1) has no special short-term debt demand. Are sophisticated and hold all bank equity.

  Supply debt to N agents via financial sector.
- Model takes bank equity and Treasury supply as given. Solves for equilibrium amount of short term debt as function of these.

Impact of Treasury Supply

F (financial sector)		N (non-financial sector)
K (Capital)	D^F — Deposits →	D^N
θ_T^F (Treasury Bonds)	W_0^F (Equity)	θ_T^N

- Non-fin sector views D and θ and as substitutes.

$$\max_{D^N,\theta_T^N} c_0^N + v\left(\frac{D^N}{1+r_D} + \frac{\theta_T^N}{1+r_T}\right) + D^N + \theta_T^N$$

- Fin sector picks D and θ to maximize mean return on equity minus penalty on variance

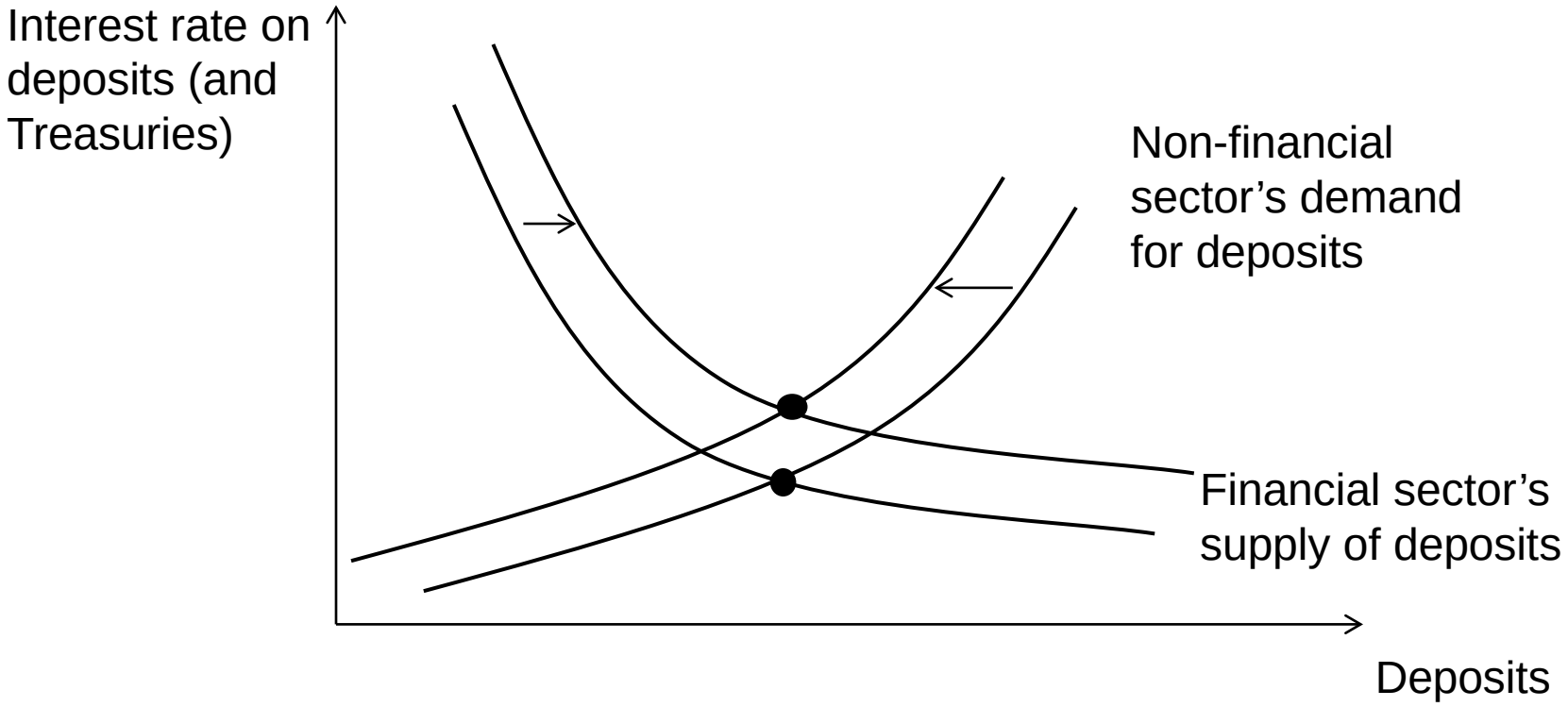
Impact of Treasury Supply

F (financial sector)		N (non-financial sector)
K (Capital)	D^F Deposits →	D^N
θ_T^F (Treasury Bonds)	W_0^F (Equity)	θ_T^N

- Non-fin sector views D and θ and as substitutes.
- Fin sector picks D and θ to maximize mean return on equity minus penalty on variance

$$\max_{D^F-\theta_T^F} E\left[(1+\tilde{r})W_0^F + \frac{D^F-\theta_T^F}{1+r_D}(\tilde{r}-r_D)\right] - \frac{1}{2}\left(W_0^F + \frac{D^F-\theta_T^F}{1+r_D}\right)^2 \sigma_r^2.$$

Impact of increase in Treasury supply:



- Non-financial sector's demand for deposits shifts left
- For a given interest rate on D, the financial sector views Treasuries as more attractive (given the higher interest on Treasuries) → They shift their mix towards Treasuries, and are
- happier with the assets → Shift their deposit supply right.

Impact on "net supply"

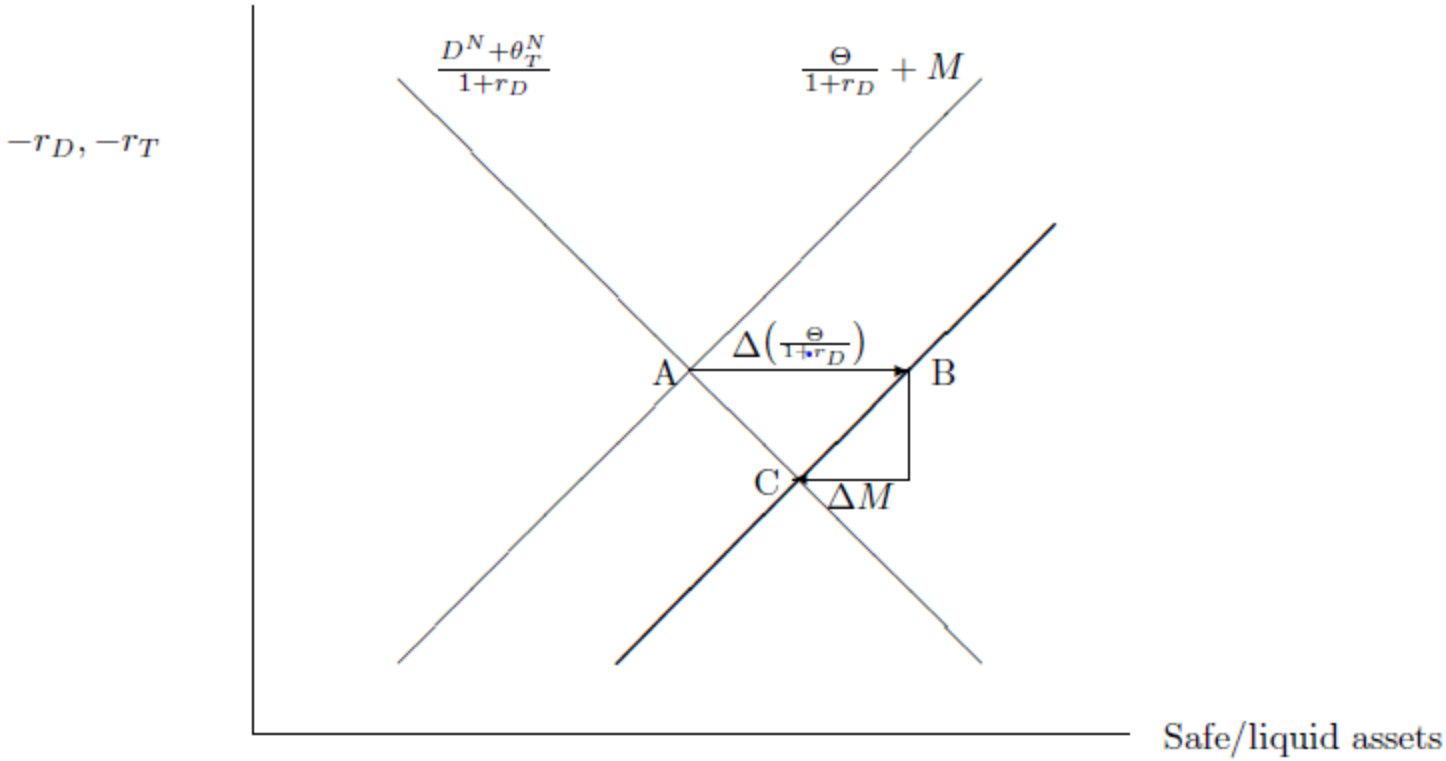
DEFINE: $$M = \frac{D^F - \theta_T^F}{1 + r_D}.$$

F SECTOR:

$$\max_{D^F - \theta_T^F} E\left[(1+\tilde{r})W_0^F + \frac{D^F - \theta_T^F}{1+r_D}(\tilde{r} - r_D)\right] - \frac{1}{2}\left(W_0^F + \frac{D^F - \theta_T^F}{1+r_D}\right)^2 \sigma_r^2.$$

MKT CLEARING:

$$\begin{aligned} \frac{\theta_T^N + D^N}{1+r_D} &= \Theta - \frac{\theta_T^F - D^N}{1+r_D} \\ &= \Theta + \frac{D^F - \theta_T^F}{1+r_D} \end{aligned}$$



Increase in Treasury supply:

1. M falls, premium falls
2. Total lending falls
3. Less risky lending, less short-term debt ⇒ Less crises

4. Defining government supply in the data

- We are interested in the government's supply of safe and liquid assets, θ.
- Main component is Treasury securities, but one could also consider the role of the Fed.

Government sector net supply of safe and liquid instruments

= Treasuries at market value

+ [Reserves

+ Currency, except for part held by Treasury

+ Net security repo agreements issued by Fed

− Treasury securities held by Fed]

- Avg. govt. net supply/GDP=0.47 of which Federal reserve component averages 0.055.

5. Constructing an overall balance sheet for the entire U.S. financial sector

Include all net suppliers of safe/liquid assets, not just com. banks.

- From 1952 we use the Flow of Funds sectors below.

  Prior to 1952 we use data for "All Banks" (i.e. commercial banks and mutual savings banks) from All Bank Statistics.

Net out interbank claims: Our model does not address these.

- For each financial instrument, e.g. commercial paper, use financial sector's assets minus liabilities.

Then sort instruments into those that are net assets and those that are net liabilities for the financial sector, based on averages from 1914-2011 of the ratio (Assets-Liabilities)/GDP.

- 33 different types of instruments show up as an asset and/or liability of one or more of the 14 parts of the financial sector

L.110 U.S.-Chartered Commercial Banks

L.111 Foreign Banking Offices in U.S.

L.112 Bank Holding Companies

L.113 Banks in U.S.-Affiliated Areas

L.114 Savings Institutions

L.115 Credit Unions

L.121 Money Market Mutual Funds

L.127 Finance Companies

L.129 Security Brokers and Dealers

L.130 Funding Corporations

L.124 Government-Sponsored Enterprises (GSEs)

L.125 Agency- and GSE-Backed Mortgage Pools

L.126 Issuers of Asset-Backed Securities (ABS)

L.128 Real Estate Investment Trusts (REITs)

Panel B. Instruments that are net liabilities on average across years

Instrument	(Liabs.-Assets) /GDP			Assets ($B)	Liabs. ($B)	Liabs.-Assets ($B)
	Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Short-term debt						
17. Checkable deposits and currency	20.5	3.6	6.7	209	708	499
18. Savings and time deposits	36.6	50.4	54.0	388	7,463	7,074
19. Money market mutual fund shares	3.2	14.8	12.8	702	2,780	2,078
20. Federal funds and security RPs	1.9	11.6	2.3	702	2,324	1,623
21. Securities loaned (for funding corporations)	1.1	10.1	4.8	0	1,415	1,415
22. Commercial paper	1.1	2.4	0.1	961	1,300	338
23. Interbank liabilities to foreign banks	0.3	0.2	1.2	0	28	28
24. Interbank liabilities to domestic banks	0.3	0.1	0.7	0	18	18
25. Security credit	0.3	4.6	4.6	432	1,078	646
26. Acceptance liabilities	0.1	0.0	0.0	0	0	0
27. Taxes payable	0.1	0.3	-0.2	0	38	38
Sum	65.6	98.1	87.0	3,393	17,150	13,757
Long-term debt						
28. Agency- and GSE- backed securities	6.1	30.2	30.0	2,846	7,077	4,231
29. Corporate and foreign bonds	0.9	22.9	14.3	2,828	6,037	3,209
Issued by ABS issuers	3.0	27.4	13.3	0	3,841	3,841
Issued by other fin. inst's	-2.1	-4.5	1.0	2,828	2,196	-632
30. U.S. govt. loans to GSEs	0.02	0.0	0	0	0	0
Sum	7.0	53.0	44.4	5,674	13,114	7,440

Instrument	(Liabs.-Assets) /GDP			Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)
	Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Equity						
31. Financial sector equity	6.9	10.5	12.6	0	1,475	1,475
32. Investment by bank holding companies (in bank subsidiaries), or by parent (in savings inst. and finance comp.'s), or by affiliates (for security brokers and dealers) or by funding corp.'s in security brokers and dealers	1.1	4.7	6.5	1,623	2,280	656
33. Foreign direct inv. U.S.	0.2	2.0	2.1	0	280	280
Sum	8.2	17.2	21.2	1,623	4,034	2,411
Overall sum	80.9	168.3	152.6			

Figure 1. Financial sector balance sheet, 1914-2011
Panel B. Instruments that are net liabilities on average across years

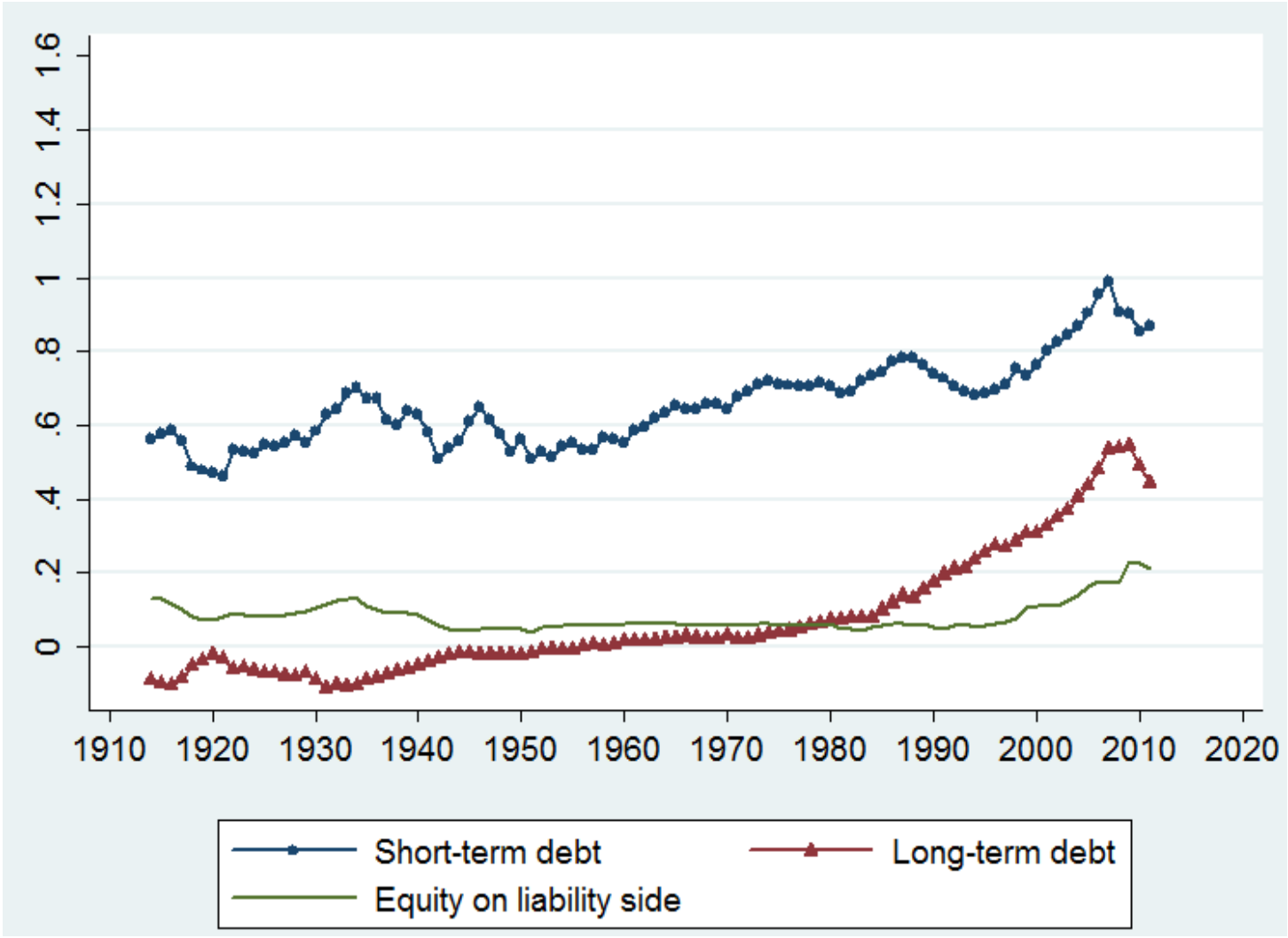
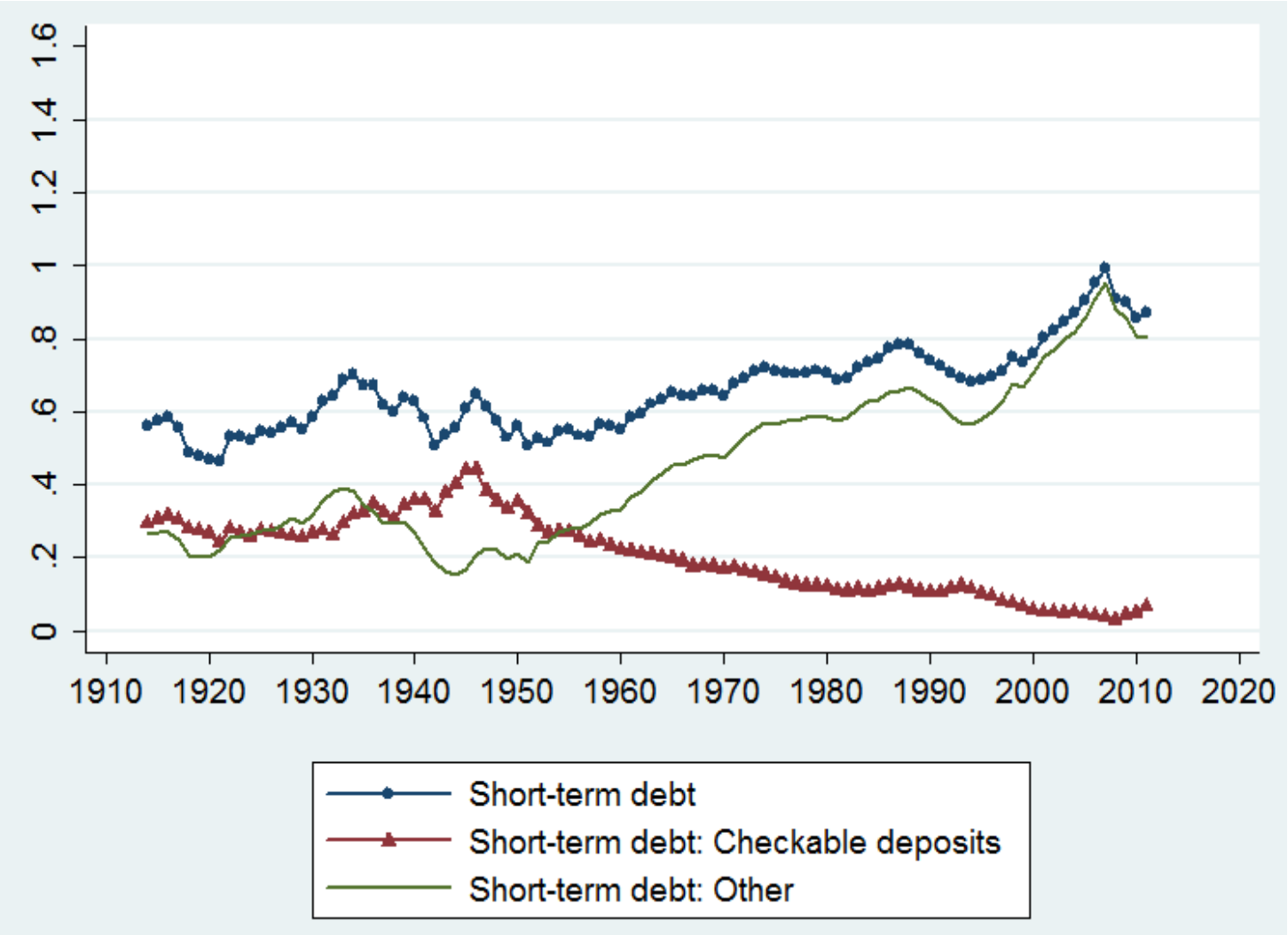


Figure 1. Financial sector balance sheet, 1914-2011
Panel C. Sub-components of short-term debt



- Checkable deposits and other short-term debt tends to move in opposite directions.

Table 2. Financial sector balance sheet, 1914-2011

Panel A. Instruments that are net assets on average across years

	Instrument	(Assets-Liabs.) /GDP			Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)
		Avg for 1914-2011	End of 2007	End of Q3 2011	End of 2007		
Assets supplied by govt (Treasury/ Federal Reserve)							
1.	Treasury securities	11.2	1.8	5.6	245	0	245
2.	Vault cash and reserves at Federal Reserve (assets), Federal Reserve float+Borrowing from Fed Res banks (liabilities)	4.0	0.5	10.9	64	-1	65
	Sum	15.1	2.2	16.5	310	-1	310
Short-term assets							
3.	Customers' liability on acceptances	0.3	0.0	0.0	0	0	0
4.	Foreign deposits	0.2	0.7	0.6	102	0	102
5.	Trade credit	0.1	0.3	0.2	105	62	42
	Sum	0.6	1.0	0.8	207	62	145
Long-term assets							
6.	Mortgages	31.5	96.2	83.0	13,520	154	13,365
7.	Bank loans	15.2	11.9	11.7	1,915	261	1,654
8.	Consumer credit	7.9	18.2	14.1	2,531	0	2,531
9.	Municipal securities	3.9	3.9	1.4	713	167	546
10.	Miscellaneous	3.3	21.7	11.6	3,432	413	3,019
11.	Other loans and advances (loans made by GSEs or finance companies, syndicated loans, other)	2.6	7.9	5.9	1,898	796	1,101
	Sum	64.3	159.9	127.8	24,009	1,792	22,217

Mapping balance sheet into the concepts of the model

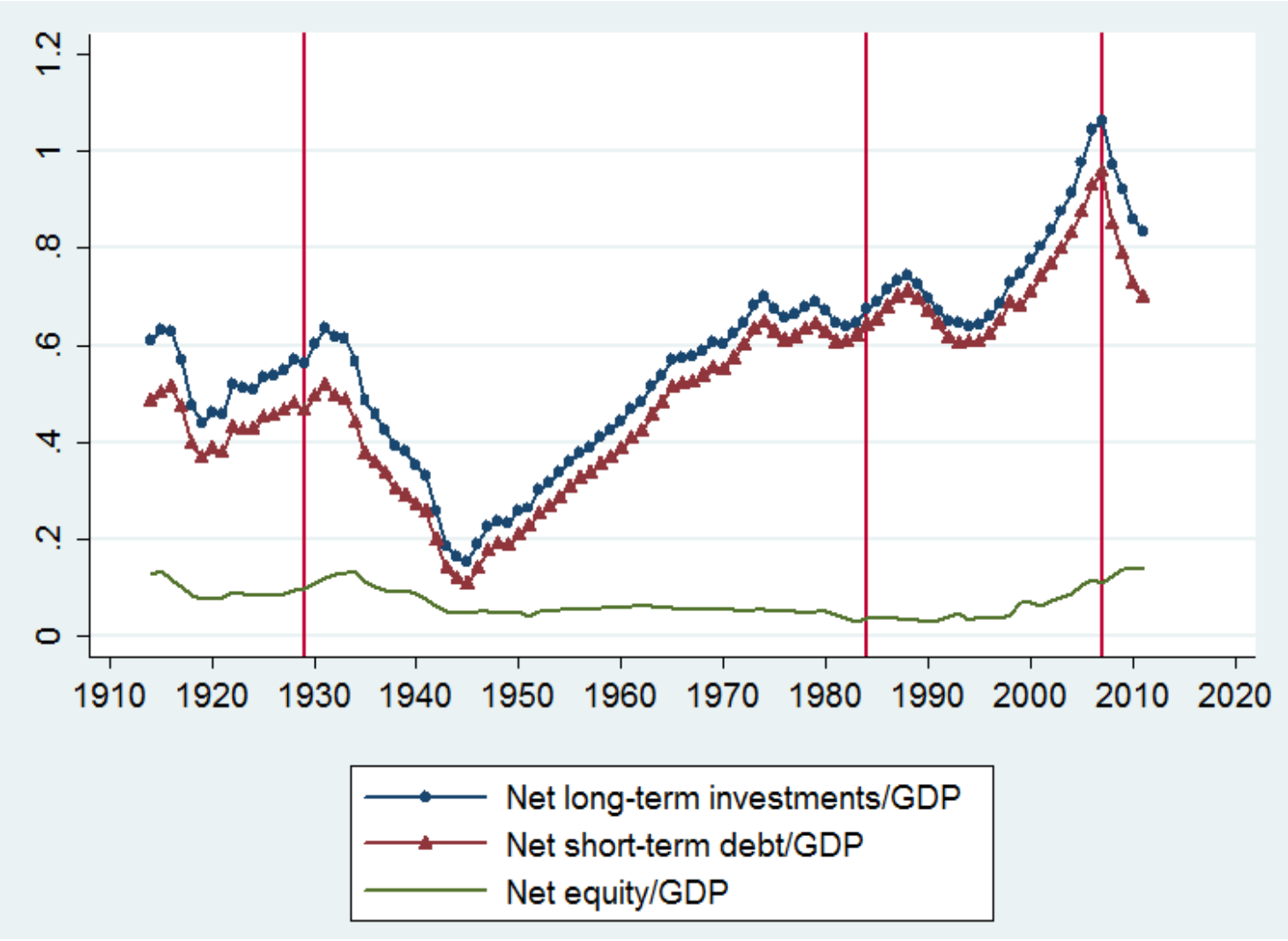
- Quantitatively the main netting issue is making sure to subtract the financial sector's holdings of govt. supplied assets.

- ST assets: Do not map well to K (unlikely to be very risky/illiquid) → Subtract them from ST debt
  → Net ST debt=ST debt-ST assets-Assets supplied by govt.
- LT debt: Does not fit well into the model (unlikely that long-term financial sector debt satisfies the N agents' special demand for very safe assets) → Subtract it from LT assets
  →Net long-term investments=LT assets-LT debt
- Equity on asset side: Could consider it part of K, or net it against equity on liability side (we do latter)
  →Net equity=Equity on liability side-Equity on asset side

Table 2. Financial sector balance sheet with short, long, and equity categories netted, 1914-2011

Instrument	(Assets-Liabs.) /GDP			Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)	Assets ($B)	Liabs. ($B)	Assets-Liabs. ($B)
	Avg for 1914-2011	End of 2007	End of Q3 2011	End of Q4 2007			End of Q3 2011		
Net long-term investments									
=(Long-term assets)-(Long-term debt)	57.1	105.6	83.5	18,315	-11,322	14,812	16,872	-9,282	12,671
Overall sum	57.1	105.6	83.5	18,315	-11,322	14,812	16,872	-9,282	12,671
Net short-term debt									
=(Short-term debt)-(Short-term assets)-(Assets supplied by government)	50.3	94.8	69.8	3,910	17,212	14,212	5,652	16,240	15,817
Net equity									
=(Equity on liability side-(Equity on asset side)	6.8	10.5	13.7	2,558	4,034	3,346	3,136	5,212	4,364
Overall sum	57.1	105.3	83.5	6,469	21,246	17,558	8,787	21,452	20,181

Figure 1. Financial sector balance sheet, 1914-2011
Panel D. Short, long, and equity categories netted



- Fluctuations in net LT investments are driven almost entirely by fluctuations in net ST debt.

6. Empirical tests – main results

- An increase in government supply:

  P1. Decreases net short-term debt (ST liabs-ST assets-fin. sector's holdings of govt. supplied assets)

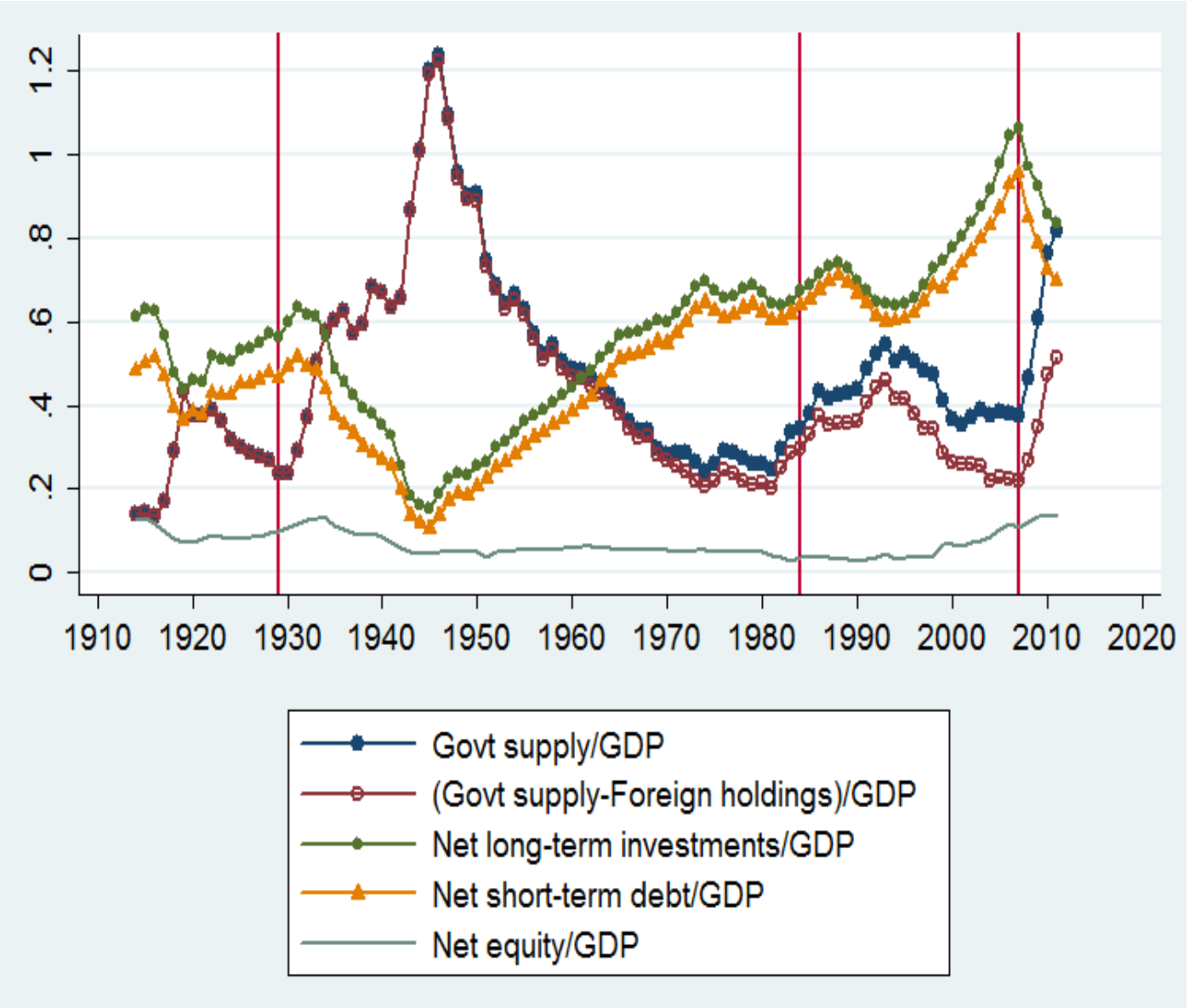
  P2. Decreases net long-term investments (LT asset-LT liabs)

Table 4. Impact of Treasury supply on financial sector balance sheet, 1914-2011
Panel A. Short, long, and equity categories netted

	Govt. supply/GDP	Year	R2	Partial R2 of Govt.
Net long-term investments	-0.506	0.005	0.765	0.332
=(Long-term assets)-(Long-term debt)	(t=-3.84)	(2.62)		
Net short-term debt	-0.486	0.005	0.853	0.325
=(Short-term debt)-(Short-term assets)	(-5.02)	(4.49)		
-(Assets supplied by US govt./Federal reserve)				
Net equity	-0.020	-0.0003	0.118	0.022
=(Equity on liability side-(Equity on asset side)	(-0.47)	(-0.45)		

- Scale all quantity variables by GDP. OLS regressions with std. errors assuming AR(1) error terms. Constant included (not reported).
- Strong support for govt. supply crowding out net short-term debt (P1) and net long-term investments (P2)

Figure 2. Impact of government supply on financial sector balance sheet, 1914-2011
Panel A. Impact on short, long, and equity net categories



Endogeneity?

- Business cycle boom drives up bank lending, bank financing, at the same time that government runs surplus and Debt/GDP falls.
  - We need to control for standard business cycle drivers of bank lending
- Higher deficits indicate future taxation which directly reduces loan demand
  - Control for recent deficits
- Financial crisis leads to disintermediation (less bank debt) and increase in government debt
  - Drop years after crisis

Table 6. Three additional approaches to address endogeneity concerns

Panel A. Controls for loan demand. Dropping most problematic years.

	Dependent variable: Net short-term debt(t)/GDP(t)					
	(1)	(2)	(3)	(4)	(5)	(6)
Govt. supply(t)/GDP(t)	-0.486	-0.309	-0.320	-0.556	-0.487	-0.516
	(t=-5.02)	(-4.81)	(-5.48)	(-5.03)	(-5.67)	(-4.84)
Real GDP(t)/Real GDP(t-5)		-0.094				
		(-2.20)				
Primary deficit/GDP, year t-4 to t				0.119		
				(1.36)		
Primary deficit/GDP, year t+1 to t+5				-0.053		
				(-0.83)		
Year	0.005	0.007	0.007	0.004	0.004	0.004
	(4.49)	(9.24)	(10.82)	(4.85)	(4.59)	(2.90)
R^2	0.853	0.928	0.923	0.900	0.886	0.878
Sample	1914-2011	1934-2011	As (2)	1918-2004	As (4)	Drop year t to t+9 after financial crisis

2) Include controls for recent GDP growth and current budget deficit. Results hold up.

Why? Because government supply has little cyclicality on average. It increases during recessions but also during wars which (in US history) are expansionary.

We also drop the most problematic years with respect to reverse causality, namely those following financial crisis (crisis drives ST debt down and government supply up).

3) Test whether positive demand shock for safe/liquid assets has opposite impact on fin. sector's net supply of short-term debt: Increase in foreign holdings of Treasuries since the early 1970s.

- US trade deficits that underlie this build-up are unlikely to directly cause an increase in US short-term debt (if anything corporate loan demand in the US would decline as more is produced abroad).

- Effect may be larger (in absolute value) than that of government supply since foreign Treasury purchases:
  - Crowd in ST debt in by ``removing'' govt. supply.
  - May correlate with foreign purchase of ST debt, thus increasing ST debt demand.

	Dependent variable:	
	Net short-term debt/GDP	Net long-term investments/GDP
	(1)	(2)
Govt. supply/GDP	-0.508	-0.537
	(-8.41)	(-7.77)
Foreign Treasury holdings/GDP	1.375	1.993
	(4.04)	(5.12)
Year	0.002	0.001
	(2.67)	(0.83)
R^2	0.923	0.903
Sample	1914-2011	1914-2011

4) Examine composition of household expenditures.

- Consider expenditures on ``credit goods'' (products often bought on credit): NIPA categories "Durable goods"+"Housing and utilities
- Treasuries should crowd out such purchases by crowding out funding from banks.
- Because we have agreed upon models of budget shares (Deaton and Muellbauer (1980)), this can be tested without omitted variables concerns:

$$BudgetShare_t^C = \beta_X \ln(Expend_t) + \beta_P \ln\left(\frac{P_t^C}{P_t}\right)$$

If Treasuries matter for budget share controlling for total consumption and relative prices it must be via its impact on funding.

Panel C. ``Rajan-Zingales identification'': Household expenditure shares for ``credit goods''. Are expenditure shares for products often bought with borrowed money higher when government debt supply is smaller?

	Dependent variable: Expenditure share of products often bought with borrowed money	
	(1)	(2)
	Coef.	Coef.
Govt. supply/GDP	-0.064	-0.081
	(t=-4.16)	(-4.41)
Log(real expenditure)	0.051	0.011
	(5.38)	(1.93)
Log(price of products often bought with borrowed money/price of all expenditure)	0.216	
	(5.52)	
R^2	0.814	0.696
Sample	1929-2011	1929-2011

Note: t-statistics in parenthesis. Estimations in all three panels are by OLS with standard errors estimated assuming AR(1) error terms. Regressions include a constant (not reported for brevity). Expenditure on products often bought with borrowed money is defined as the sum of expenditure on durable goods and on housing and utilities. Expenditure data are from NIPA Table 2.3.5 and price data from NIPA Table 2.4.4.

We ask: Are consumption expenditures for products where buyers for technical reasons (usefulness as collateral+size of purchase) often buy them on credit larger in periods with less Treasury supply.

- Good: Controls for the fact that private borrowing and Treasury supply may both be driven by some unobservable (wars/the business cycle).
- At first not so good: Identification doesn't work if the driver of Treasury supply affects expenditures on products usually purchased with borrowed money differently.
- However!!! Theory tells us that there should be very few drivers of budget shares above and beyond funding conditions (total consumption, relative prices). We can control for these.

Two additional results

- Treasury supply and M1
  - Can help stabilize money demand functions ("missing money" puzzle)
- Short-term debt helps predict crises
  - Better than private credit growth

7. Money/Liquidity demand

- Suppose households value holding liquid balances, L = checking deposits

$$\max_{D^{NH},\theta_T^{NH},L^{NH}} c_0^{NH} + \mu\left(\frac{L^{NH}}{1+r_L}\right) + v\left(\frac{D^{NH}}{1+r_D} + \frac{\theta_T^{NH}}{1+r_T} + \frac{L^{NH}}{1+r_L}\right) + D^{NH} + \theta_T^{NH} + L^{NH}$$

- Financial sector needs to back up checking deposits with Treasuries and capital
  - Using capital incurs a "liquification" cost of $\Phi(\kappa)$

$$\frac{L^F}{1+r_L} \leq \frac{\theta_T^F}{1+r_T} + \kappa.$$

Impact of Treasury supply

- More Treasuries $\Rightarrow$
  1. Liquidity premium falls (checking rate rises relative to others)
  2. More deposits
  3. Treasuries are cheaper as backing; banks buy more Treasuries
  4. Treasury/Deposit ratio rises

- Predictions for M are unchanged

- Accounting for the effects of Treasury supply, as in our model, as well as changes in foreign holdings of Treasuries, can help account for the ``missing money''.

Panel C. Instruments that are net liabilities on average across years

	Govt. supply/GDP	Year	R2	Partial R2 of Govt.
Short-term debt	-0.042	0.003	0.671	0.007
	(t=-0.52)	(3.77)		
Liquid ST debt:				
Checkable deposits	0.223	-0.003	0.942	0.196
	(6.19)	(-9.32)		
Other ST debt	-0.269	0.007	0.898	0.081
	(-2.98)	(5.95)		
Long-term debt	0.017	0.005	0.777	0.000
	(0.27)	(4.20)		
Equity	-0.020	0.0003	0.048	0.012
	(-0.39)	(0.22)		
Sum (size of financial sector)	-0.045	0.009	0.710	0.001
	(-0.29)	-2.85		

- Strong support for govt. supply crowding in checkable deposits (P3)

Panel B. Instruments that are net assets on average across years

	Govt. supply/GDP	Year	R2	Partial R2 of Govt.
Assets supplied by US govt. or Federal Reserve	0.453	-0.002	0.878	0.686
	(t=8.16)	(-2.82)		
Short-term assets	-0.009	0.0002	0.722	0.086
	(-1.92)	(3.84)		
Long-term assets	-0.490	0.010	0.769	0.103
	(-2.98)	(2.93)		
Equity	0.0002	0.0006	0.635	0.000
	(0.01)	(2.35)		
Sum (size of financial sector)	-0.045	0.009	0.710	0.001
	(-0.29)	-2.85		

- And govt. supply crowds in financial sector holdings of govt. supplied assets even more, so the deposit coverage ratio is increasing in government supply (P4).

Figure 3. Impact of government supply on financial sector balance sheet, 1914-2011
Panel B. Impact on sub-components of short-term debt

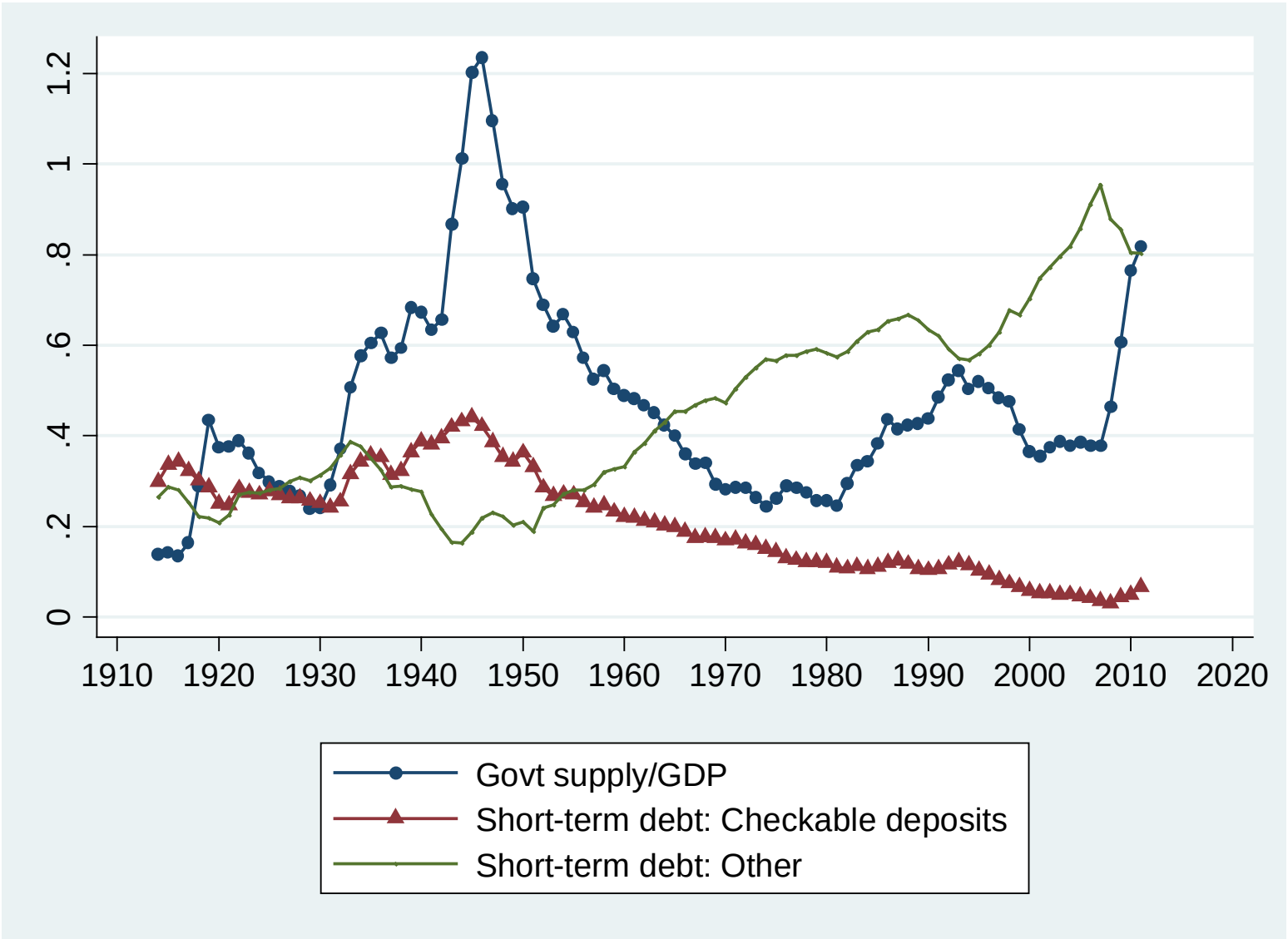


Figure 3. Impact of government supply on financial sector balance sheet, 1914-2011
Panel D. Impact on financial sector holdings of government supplied assets

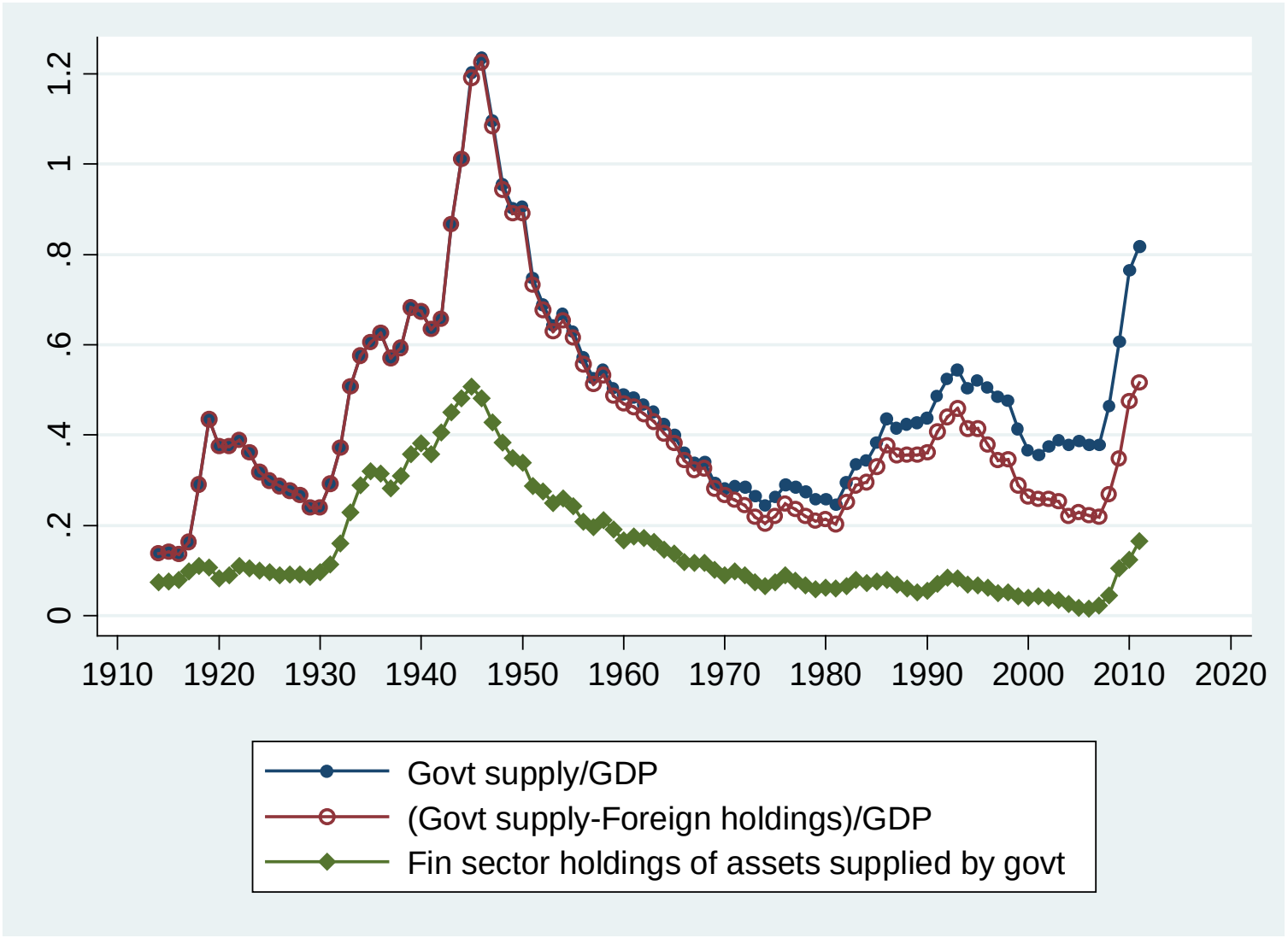
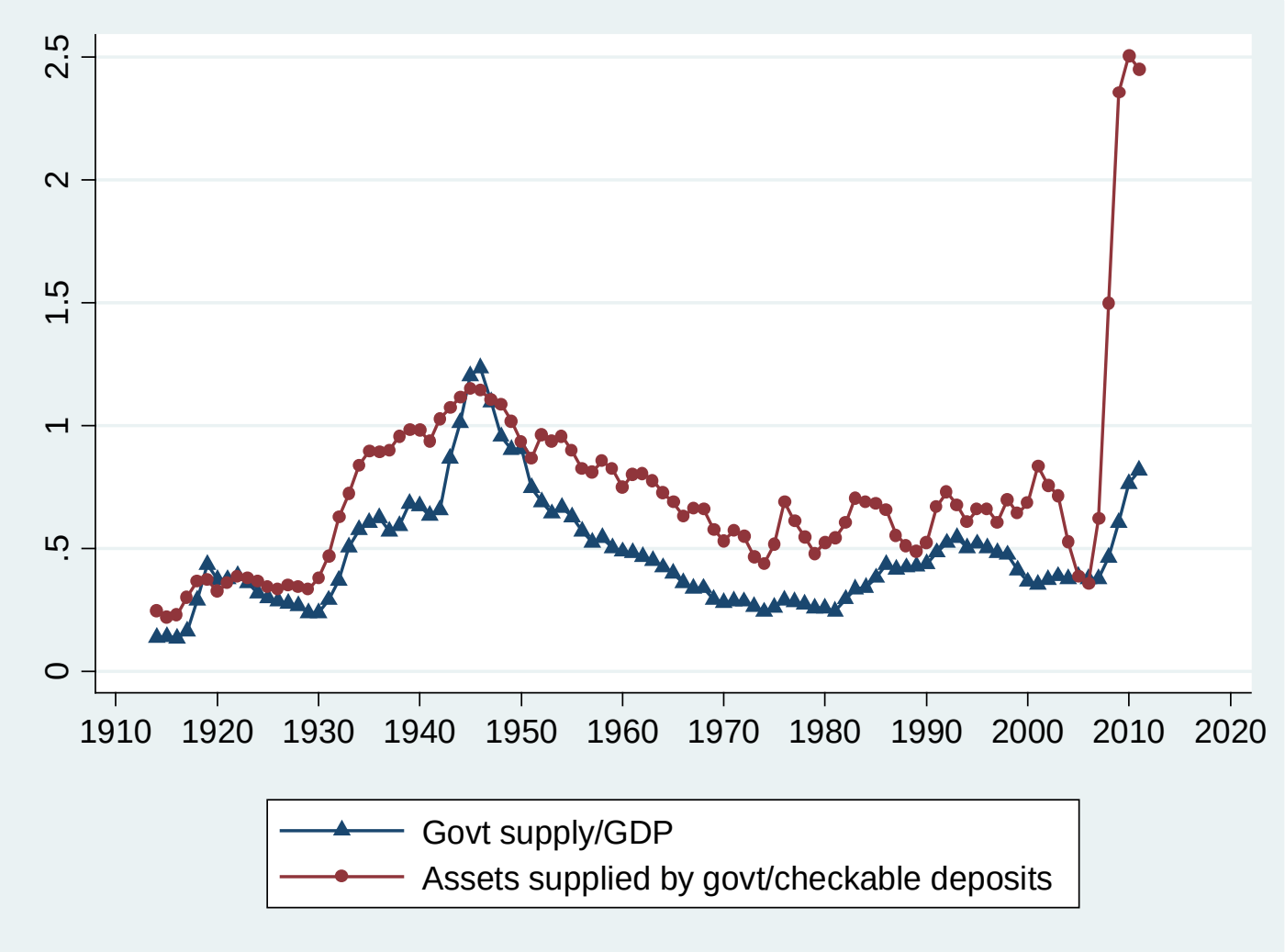


Figure 2. Impact of government supply on financial sector balance sheet, 1914-2011
Panel C. Impact on ``deposit coverage ratio'' (financial sector holdings of government supplied assets/checkable deposits)



- Strong support for Treasuries increasing deposit coverage ratio (P4)

  (Regressing the deposit coverage ratio on govt. supply/GDP and a trend results in coef.=1.15, t>2).

We can make the test of the impact of government supply on checking deposits even more stringent:

- Effect should be there even controlling for standard determinants of money demand (nominal r, nominal income).
- That's because money demand is determined by $r_D - r_L$.

  Most papers set $r_L = 0$, but often recognize that this may not be a good assumption:

  - Post-1980, financial innovation leads to the creation of checking or near-checking accounts that pay interest.
  - ``Effective'' r_L also affected by density of bank branches.

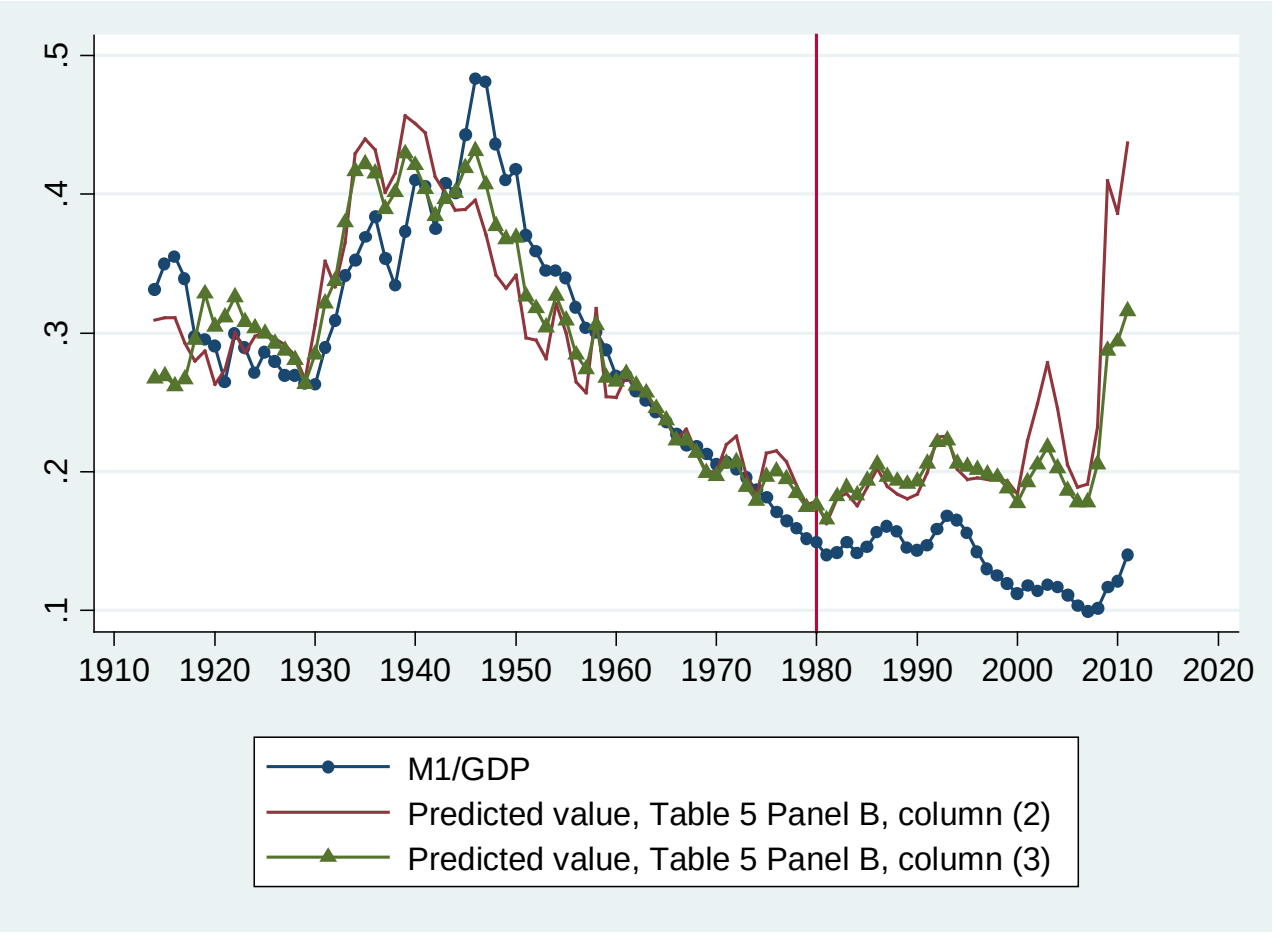
- We do not directly measure $r_D - r_L$ either but our theory suggests it is negatively affected by Treasury supply.
- Because we have agreed upon models of money demand, this can be tested without omitted variables concerns.

Panel B. Using conventional money measures from Friedman and Schwartz and the Federal Reserve's H6 release

	ln(M1/GDP)						
	1914-1979			1914-2011			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Nom. yield on	-0.267	-0.233	-0.068	-0.174	-0.115	0.043	-0.079
3-mo com. paper)	(-3.98)	(-4.37)	(-1.52)	(-1.56)	(-2.34)	(1.00)	(-2.30)
ln(Real GDP)		-0.145	-0.207		-0.362	-0.380	-0.203
		(-2.10)	(-4.46)		(-3.63)	(-7.33)	(-4.03)
Government supply/GDP			0.637			0.955	0.641
			(4.53)			(4.72)	(4.90)
Foreign Treasury holdings/GDP							-3.230
							(-4.38)
Constant	-2.183	-1.689	-1.254	-2.093	-0.761	-0.603	-1.283
	(-9.03)	(-5.81)	(-6.27)	(-13.34)	(-2.13)	(-2.92)	(-6.61)
N	66	66	66	98	98	98	98
R^2	0.650	0.783	0.896	0.143	0.792	0.906	0.955

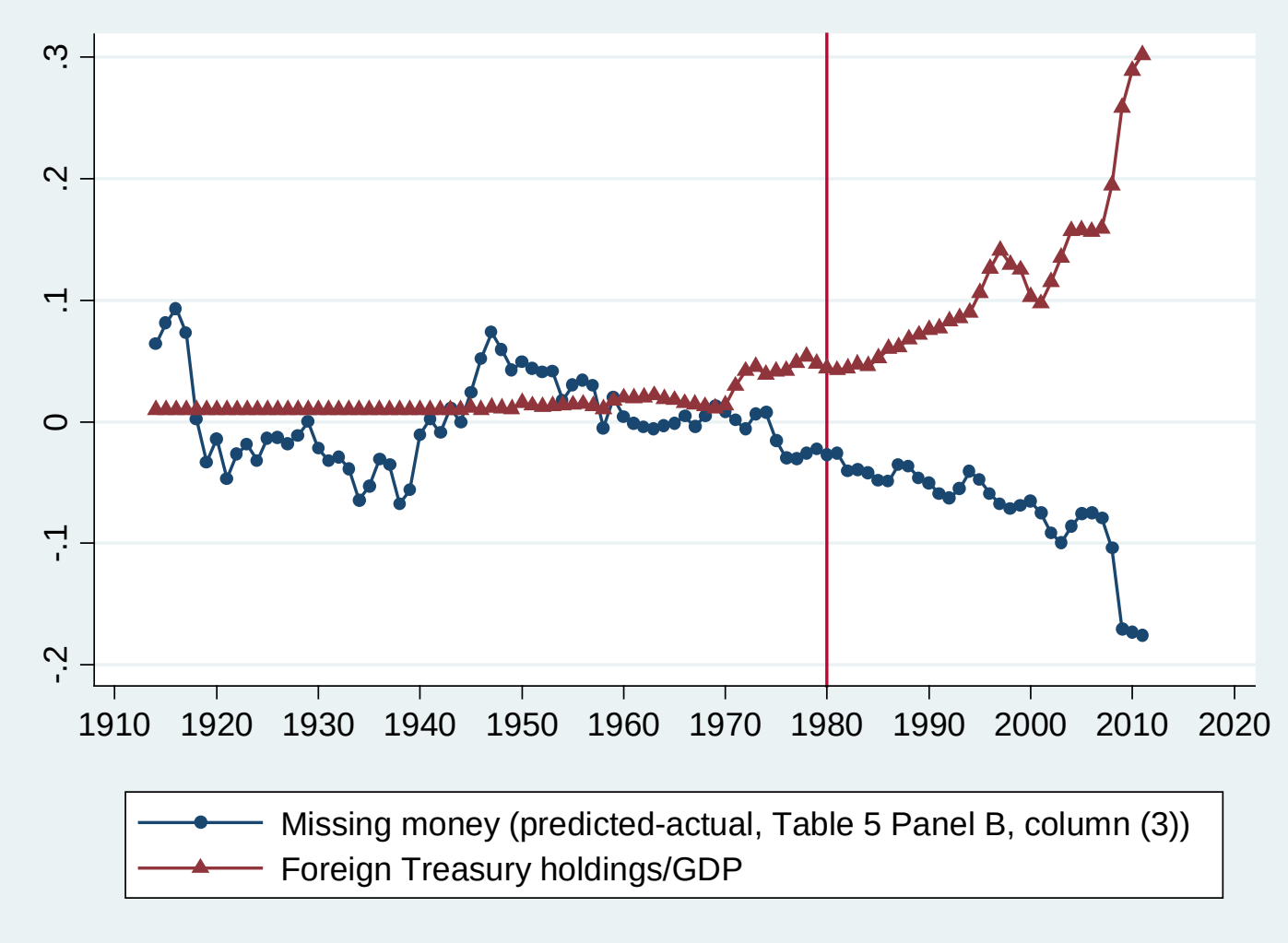
- R2 pretty high pre-80, then tiny. Allowing non-unit elasticity on income helps R2 but coefficients on nom. yield and income are unstable.
- Adding ln(Govt supply/GDP) and ln(Foreign Treasury Holdings/GDP) (not very relevant pre-1980) leads to more stable coefficients.

Figure 5. Explaining M1/GDP
Panel A. Predicted values, estimations use data from 1914-1979



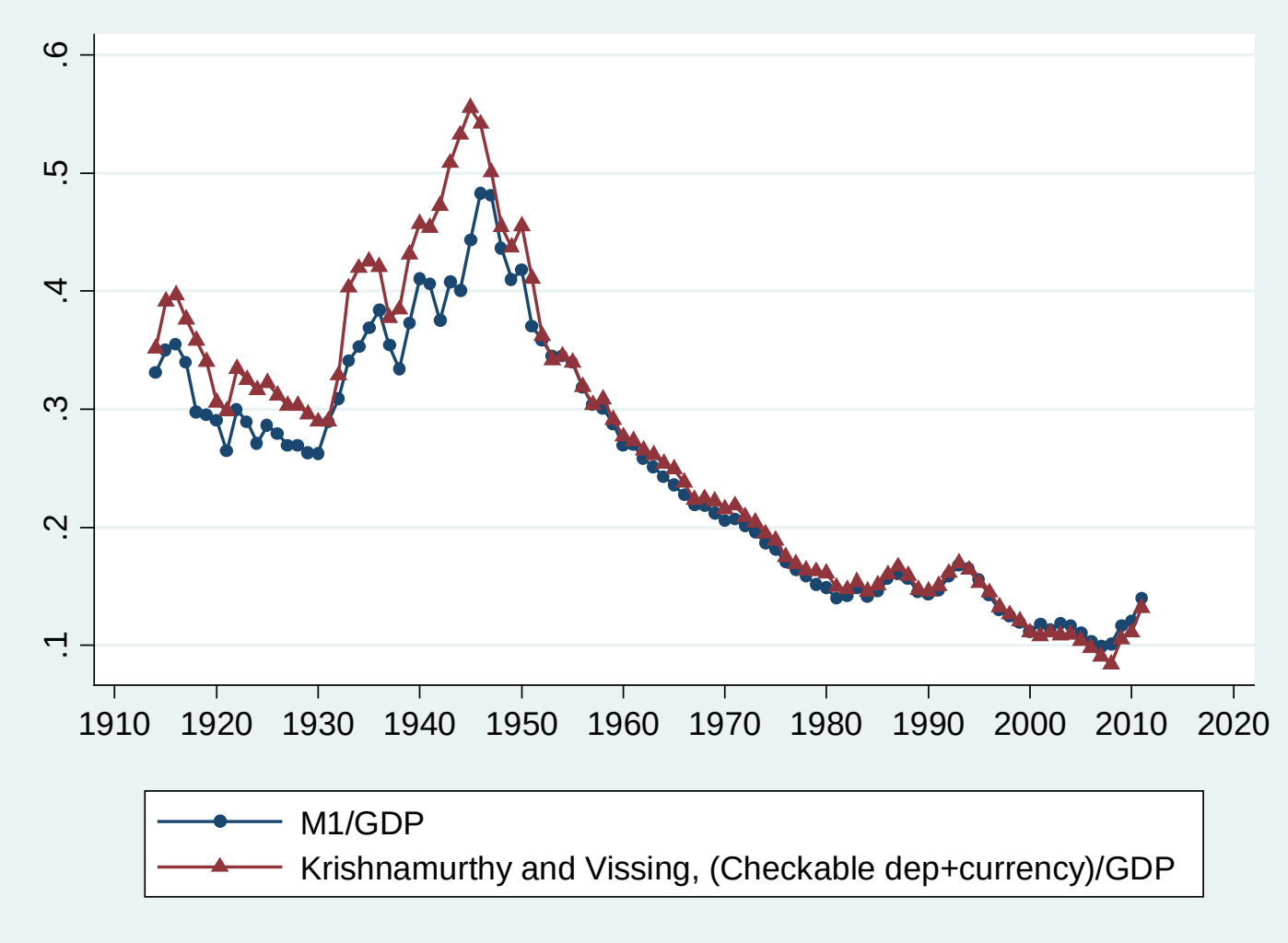
- Estimating using pre-1980 data to illustrate ``missing money'' post-1980
- Adding Treasuries helps some, but what really helps is to consider foreign Treasury holdings – see next page.

Figure 4. Explaining M1/GDP
Panel B. Relation between ``missing money'' and foreign demand for liquid/safe US assets



- Which money measure do we relate $C_D + C_L$ to? If you add currency to our checkable deposits variable you conceptually get M1 (and in practice the two series are close).

Figure 4. Money supply measures and their relation to our financial sector debt measures
Panel A. M1/GDP and our corresponding measure



Note: Should conceptually be identical absent data issues

8. Predicting financial crisis in the US, 1914-2011

- The probability of a financial crisis is:

  P5A: Increasing in net short-term debt

  P5B: Decreasing in government supply.

- Schularick and Taylor (2012): 3 crisis. 1929, 1984, and 2007.

  (Could add 1914, see e.g. Sprague, Oliver M.W., 1915, "The Crisis of 1914 in the United States," American Economic Review)

- We estimate logit models following methodology of Gourinchas and Obstfeld (2012):
  - Use data known in year t to predict crisis in year t+k (k=1 or 3)
  - Drop year t if year t itself is a crisis year or any of year t-1, t-2, t-3, or t-4 were crisis years in order to avoid mechanical biases (cannot be at risk of entering a new crisis until you get out of the current one).
  - Error terms robust to heteroscedasticity.

Table 7. Predicting banking crisis in the US, 1914-2011
Panel A. Using predictors directly

	Dummy=1 if first year of a US banking crisis is in year t+1, t+2, or				Dummy=1 if first year of a US banking crisis is in year t+1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net short-term debt/GDP		24.277				21.36		
		(t=2.99)				(1.78)		
Private credit/GDP			8.100				7.195	
			(3.25)				(1.75)	
Government supply/GDP				-18.75				-12.674
				(-4.09)				(-3.50)
Foreign Treasury holdings/GDP				21.287				15.627
				(2.10)				(1.01)
Year	0.015	-0.099	-0.07		0.016	-0.094	-0.066	
	(0.79)	(-2.47)	(-2.34)		(0.48)	(-1.43)	(-1.30)	
Area under ROC curve (AUROC)	**0.628**	**0.865**	**0.783**	**0.873**	**0.631**	**0.862**	**0.747**	**0.818**
Std. error for AUROC	0.137	0.065	0.085	0.047	0.265	0.127	0.198	0.092
T	78	78	78	78	78	78	78	78

- Net short-term debt predicts crisis positively (P5A), better than the most popular predictor Private credit/GDP (see AUROCs)
- Govt supply predicts crisis negatively (P5B)

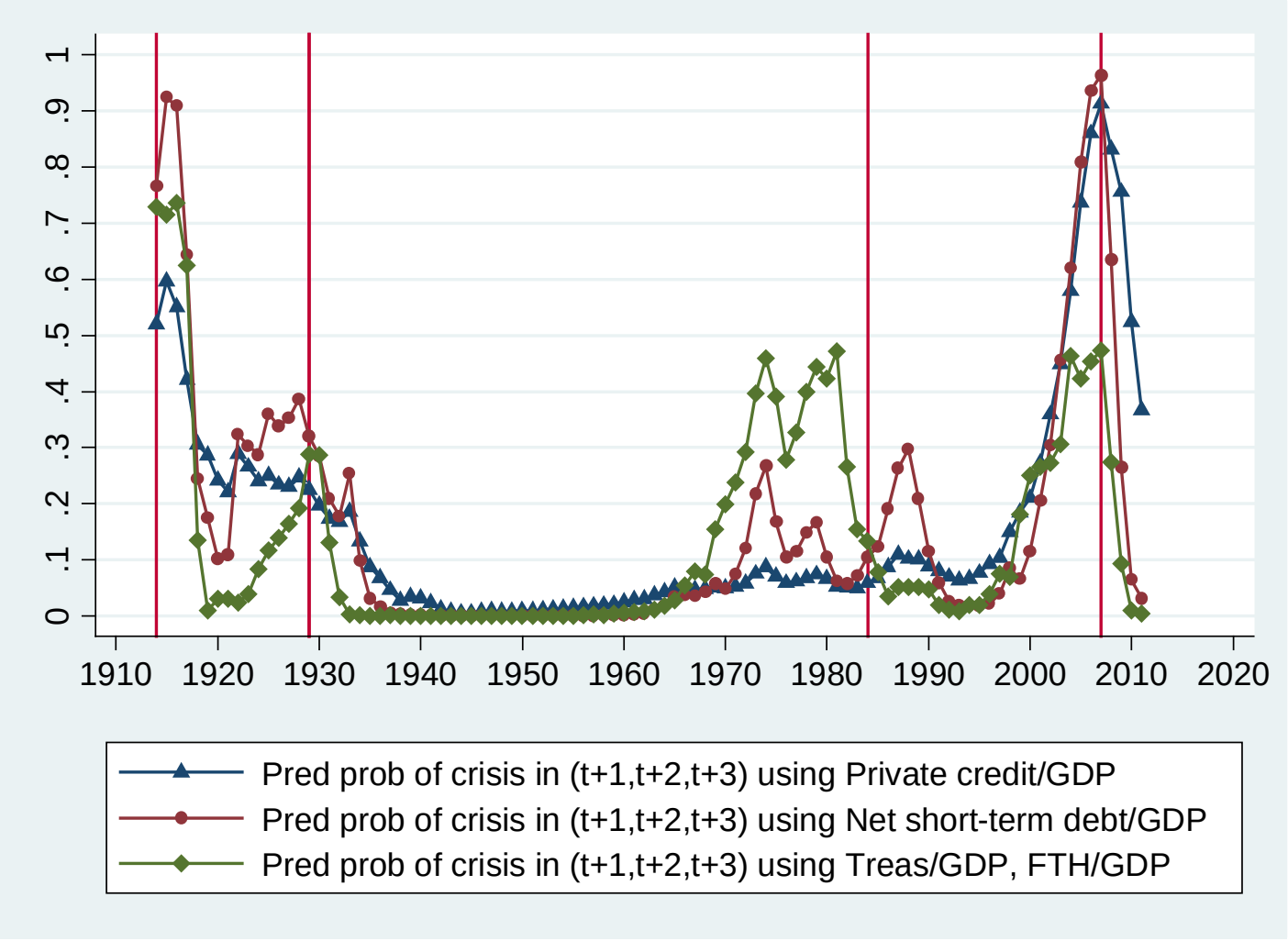
- Comparing net short-term debt and private credit:

  Net short-term debt
  =Net long-term investment-Net equity
  =(LT assets-LT liabs)-Net equity

  LT assets are close to Private credit/GDP (ST assets are tiny).
  So differences between the two predictors are LT liabs and equity.

- Results suggest that if a lot of LT assets are financed with LT liabilities or equity then they are not as crisis-prone.

Figure 7. Predicting banking crisis in the US, 1914-2011
Panel A. Predicted crisis probability, full sample



Tentative conclusions

- Financial sector short-term debt driven largely by moneyness of such debt
  - … not government insurance of deposits, taxes, agency theories
- We investigate by looking at variation in Treasury supply
- Helps to understand key determinant of financial crises
- Helps to understand missing money puzzle